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ABSTRACT

This document details the administrative issues associated with guiding a school district through its metrication efforts. Issues regarding staff development, curriculum development, and the acquisition of instructional resources are considered. Alternative solutions are offered. Finally, an overall implementation strategy is discussed with specific recommendations and supporting rationale presented. An implementation time line extending over three to five years is included. (Author/MN)

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COMPREHENSIVE METRIC EDUCATION PROJECT

IMPLEMENTING METRICS AT A DISTRICT LEVEL

ADMINISTRATIVE GUIDE

By Michael L. Borelli

SE 024 182

INTRODUCTION

The concerns of an administrator, or district administrative team regarding metrication are primarily logistic ones. The administrators must determine how to get the district from where it is presently, minimal metric activity, to where it needs to be tomorrow, predominantly metric. They must be familiar with the issues and their alternative solutions. Ultimately, they must be prepared to recommend an overall implementation strategy for the district, and defend that recommendation with Board members, parents, and community groups.

It is the objective of this paper to highlight those administrative concerns; and to make specific recommendations regarding them. While these recommendations may be appropriate for some districts, they will in all probability require adaptation to meet the unique circumstances which apply in many other districts.

THE ISSUES - an overview

What then are the issues with which district administrators need concern themselves regarding metrics? Three critical areas of concern emerge: staff development, curricula revision, and instructional resources.

Few administrators deny that if their schools are to move to metrics, then their staffs will need some form of training. However, considerable difference of opinion exists regarding the extent of that training, who will need to receive it, and finally the manner of its delivery.

That curricula will be effected by the transition to metrics is again conceded by most; but how extensive the impact will be is subject to differing opinions. Distinctions between elementary and secondary programs seem evident, but need clarification. Will the impact only be in mathematics programs, or will it effect other program areas - and how extensively? How will the revisions by accomplished, and at what cost?

The adoption of the metric language of measurement will obviously require districts to adapt existing or acquire revised instructional materials. What is needed; what would be nice to have; and what isn't really needed at all? How will these purchases be made; what criterion will be used in the selection of materials?

If an administrative team is to effectively manage the adoption of metrics, it needs to be familiar with all of the above. Additionally, the team needs a carefully developed, detailed, rational implementation strategy or plan. Decisions need to be made regarding the number of years over which the adoption will span. The plan must provide for the coordination of the various components. It must take the district through the transition with a minimum of confusion, and a maximum cost-effectiveness ratio.

Each of the issues cited above will next be considered in isolation, and then collectively in an implementation strategy which effectively combines them into a carefully coordinated plan. Potential problem areas will be highlighted; and special consideration will be given to some unique issues associated with the transition period.

STAFF DEVELOPMENT

The staff development component of a metric implementation plan is probably the most critical aspect. Without the adequate and timely preparation of staff, no strategy however admirable it may otherwise be, can prove successful! The Interstate Consortium on Metric Education (ICME) was convened in 1974 to consider this and a number of other critical metrication issues. Twenty-eight (28) state and territory representatives met. They developed a set of 23 recommendations, now generally regarded as reliable sources of metric guidance. Five of these recommendations speak to the inservice training of teachers (#'s: 19 through 23). This partial list of recommendations is attached as Appendix A.

Briefly the ICME recommendations indicate a need to distinguish between the inservice needs of elementary teachers and those of secondary teachers, between individuals directly involved in the teaching of measurement, and those concerned only with the general application of measurement. The recommendations suggest a 10 to 16 hour program for the former, while 3 to 6 hours are indicated as sufficient for the latter. They speak directly to the point that the teaching of metrics is a multi-disciplinary concern; that while the teachers of math and science should assume the major responsibility for teaching the metric system - teachers in all subject areas must assume the responsibility for teaching applications of metrics.

While the recommendations clarify to some degree the extent of training required by various staff members, they do not speak to an issue of comparable concern to the administrator, namely how a district is to go about getting all those people trained. There are several alternatives: in-house training through inservice courses, workshops, and seminars or external training through university sponsored programs. Teachers should, ideally, be required to demonstrate to the satisfaction of the administration that they possess the required competancies. However, they should have the option of acquiring these through whichever route seems most feasible.

The district, or several districts can offer an inservice course. This 10-15 hour experience should teach teachers about metrics in the same manner that we hope they will later teach students (hands-on, activity oriented experiences supplemented with lectures). It should precede curricula implementation, but not by such an extensive period as to make the training lose immediacy. In addition to teaching them "metrics", it should also expose them to optimal instructional strategies for teaching "measurement" to children. A number of models for such an inservice course already exist (California, Hawaii, ICME,...). I have attached as Appendix B a rough outline of the course presented in conjunction with the metric project I am conducting.

Not all staff members require training as extensive as that provided by the inservice course. Additionally, there are local needs that such a course would be unlikely to meet, especially if offered on a multi-district level. Therefore, it is appropriate to supplement the inservice course with a collection of workshops. Included among these workshops should be a general awareness session appropriate to all staff in the district. This would detail why the metric system is coming, the basics of its language, and the impact it will have on schools. Such a presentation should precede all other metric activity within the district. It would also be advisable to include within this presentation the overall district implementation plan.

There should also exist a collection of topical workshops (Metrics and Industrial Arts, Metrics and Language Arts, etc.) that would form the basis for the inservice training of secondary teachers. These would supplement the general awareness presentation described above. Their specific format would be a function of the disciplines they serve; but might generally include hands on activities with metrics (1-3 hours depending upon need) followed by an exploration of the specific impact metrics would have upon that subject area.

While most teachers recognize that inservice training is a professional responsibility, there are, nevertheless, some who will fail to view it this way. The inservice course is the ideal vehicle for delivering the requisite 10-15 hours of training to those staff members requiring (or desiring) it. Not all staff members, however, will opt for such an experience. Unfortunately, those who are least likely to register for such a program, are probably the ones who most need it! While it may be tempting to require these "reluctant learners" to attend - this practice cannot be recommended. There exists an alternative with a higher degree of probable success. Require those staff members for whom extensive metric training is essential (teachers of measurement) and who cannot demonstrate that they have acquired the required metric competancies (locally or externally) to attend a mini-course (3-5 hours in duration). While such a mini-series is not totally adequate, it should serve the function of reducing some of the anxiety and thus paving the way for future training of the staff members. It will prepare them adequately to begin to use metrics in their classrooms. Supplemental training may be required at a later date.

An additional concern with respect to staff development is a purely logistic one: How do you get the training accomplished? Who to use as trainers is probably the most critical decision. There are presently in New York State a very limited supply of individuals administering such programs. However, the fruits of their labour, are for the most part, public domain. Inservice packets should eventually be available from Title IV-c projects, Math Bureau, etc. Key individuals within districts should, with these materials and limited training, be able then to administer such programs.

Another alternative which districts need to consider is to allow teachers to acquire the metric competancies they will need through university sponsored courses or workshops. The universities could also serve as facilitators in providing training at the local level. The viability of such options is, of course, of function of the proximity and sensitivity of appropriate institutions, and will vary widely from district to district.

The final concern for staff development is fiscal. The costs associated with this activity will vary according to the strategy elected, local inservice remunerative policies, whether the services are cross-contracted with BOCES or provided solely by local initiative, etc. Costs associated with consultant services, supplies, and materials for training need also to be factored in. As a purely "ball-park" estimate, based upon limited experience, I would estimate that we are talking about costs that should range somewhere between $5 to $10 per staff member in the district, plus any monies the district would offer teachers for inservice training.

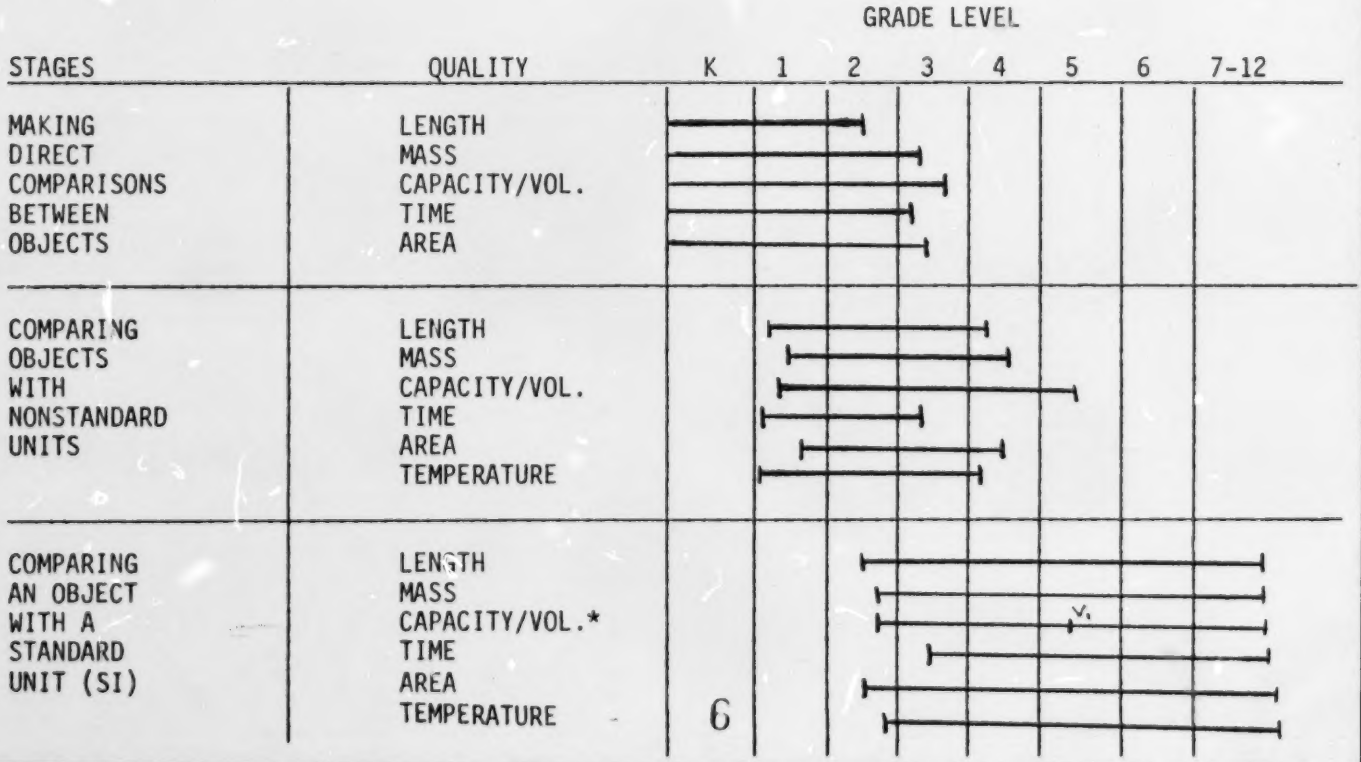
CURRICULA REVISION

Changing our nation's measurement language from Emperial inches, quarts, and ounces to metric metres, litres, and grams will clearly have a significant impact on school curricula. The extent will be determined largely by the age (grade level) of the student, and the context in which the instruction is taking place.

More replacement throughout the school curriculum of every instance of "inch", "quart", and "ounce" with their metric counterparts represents the least complex, and most easily accommodated implication of "going metric". However, going-metric provides educators a unique opportunity to reassess the manner in which we have taught our students measurement skills. Such a reassessment should assure us, as it did the National Assessment Team, that there exists significant room for improvement.

Based upon the research of Piaget, Copeland, Lovell, the Nuffield Project, etc. educators are now aware that there exists better ways to instruct young people in measurement. Any transition to metrics within a district should also include within it a general restructuring of the measurement strand within the elementary intermediate program based upon the above information. This impact of "going-metric" will in all probability be more significant, more complex, and require more pre-planning than the "replacement" impact cited earlier.

While it is difficult to encapsule changes as comprehensive as this type of restructuring suggests, the chart below attempts to summarize them. We now recognize that children acquire their measurement competencies in discrete intellectual stages. We also realize that until such time as a child comes to "conserve" a particular measurable quality of an object, that it is inappropriate to teach that child a standard unit related to that quality. We therefore, devote the primary grades to helping young people clearly perceive the qualities to be measured by having them compare and distinguish those qualities in many contexts. Students are lead through a sequence of activities allowing them to quantify various attributes first with the use of non-standard units. Depending upon the ages at which they come to "conserve" various qualities, standard metric units are phased in. This transition usually begins around grade three.



STAGES	QUALITY	GRADE LEVEL K	1	2	3	4	5	6	7-12
CHOOSING MEASUREMENT UNITS FOR SPECIFIC TASKS	LENGTH					———	———	———	———
	MASS					———	———	———	———
	CAPACITY/VOL.*					———	———	———	———
	TIME					———	———	———	———
	AREA					———	———	———	———

* SOLID VOLUME (V1)

If the recommendations of the researchers are to be fully implemented, then measurement instruction would be predominantly activity-oriented. Such instruction would reflect the various stages through which children must progress in acquiring their measurement competencies. Additionally, it would avoid totally conversion exercises between metric and imperial systems, while recognizing the need for some time to come for bilingual measurement instruction. However, metric instruction would be first and foremost, allowing imperial units to be taught as a second language.

Another significant factor associated with the restructuring of the elementary measurement strand, is the corequisite need to restructure the arithmetic strand. Metrics is by its very nature a decimal language of measurement. Instruction in decimal numerals, therefore, can no longer wait until grade 5 or 6. Most restructurings place decimal numerals into grade 4 or lower. Given the close similarities between the algorithms for whole numbers and those for decimal numerals, improved mastery can be anticipated. Details regarding the objectives by grade level should be forthcoming from local state education departments in the very near future. States such as California and Hawaii as well as several districts within New York have models upon which programs could be based.

A change clearly related to the earlier placement of decimal numerals in the math curriculum, is the reallignment in that same curriculum of common fractions. Instruction in fractions can be divided arbitrarily into two categories: conceptual and algorithmic. Students will continue to require familiarity with the concept of common fractions, however, there will be little need for most to develop mastery with the basic algorithms. For those who do require such skills they can more appropriately be offered in a pre-algebra environment in junior high school programs. Thus, the elementary school program will find itself concentrating on instruction related to the concept of a fraction (through the use of concrete models) and on the equivalence of fractions and between fractions and decimals.

Virtually all other curricula areas in the K-12 program need only concern themselves with the "replacement" impact that conversion to metrics will have on their program areas. A home economics class still has as its basic objectives a certain set of performance skills. These skills are unaffected by changes in measurement language. The same could be said for virtually every other area. This is not to imply that only the elementary math teachers will be effected. Teachers in secondary programs will need to assess to impact replacing one language of measurement for another will have on their programs. For some this impact will be minimal, for others it will be more significant. But for virtually no area will the impact be non-exist.

INSTRUCTIONAL RESOURCES

Introducing metrics into a district's instructional program will require the district to provide its staff with appropriate resources for use in the classroom. Above all others, it is this requirement which usually meets with the most vocal protestations from community groups and boards of education. They probably envision every book, paper, and piece of equipment in the building being loaded on a dump-truck, all to be replaced with nice, new, expensive goodies. They are frequently countered by the metric prophets preaching conversion at virtually no cost. The truth lies somewhere between those extremes.

Resources effected by metric conversion include: text books, audio-visual aids, maps, charts, measurement instruments and instructional supplies. Virtually all of these presently within the district, have given life expectancies. For example, most school purchased text books with a life expectancy of five or so years. In phasing metrics into a district these life expectancies should be taken into consideration - don't adopt a new text book series the year before you revise a sensitive curriculum. Supplement existing texts with teacher materials, as long as it is feasible to do so.

There are some items that will have to be purchased, particularly measuring instruments new to the elementary classroom. These do not all have to be purchased the first year, and can be phased in with the instructional program. The chart below details what resources would be appropriate for math or science classrooms where the primary responsibility for teaching metrics is placed. Other listings are available.

To implement "metrics" in the K-6 math/science programs the following materials would be appropriate. Not all materials would be needed in each classroom, some could be shared - such materials are indicated with an asterisk. All numbers are for a class of 30, shared materials for 3 or fewer classes.

	Grades: K-1	2	3	4-6	Description
	1	1	1		Metre stick (no calibrations)
*		10	10	10	Metre stick (cm calib. K-4)
		30	30	30	30 cm ruler (cm calib. K-4)
		1	1	1	Teacher's demo metre stick (4 sided)
		5	5	5	Vinyl tape measure (150 cm)
*	1	2	2	2	Trundle Wheel
	1	1	1	1	Wall height chart
*	1				Primary Balance (bucket)
*		1	2	2	Elementary Balance (pan)
				1	Platform Spring Scale (dial)
	1	1	1	1	Package Centicubes (1,000)
		1	2	2	Stacking Plastic Masses (set)
*		1	1	1	Elementary bar mass pieces (set)

	K-1	2	3	4-6	Description
*				1	Set Precision Mass Pieces
	1	2	2	2	Mesh Weighing bags (pkg. 10)
*	1	1	1	1	Personal (bath) scale
			4	4	Pull Spring Scales
		1	2	2	Litre Measuring Pitcher
*		1	1	1	Multi-shape Litre set
*		1	2	2	Plastic Litre box - graduated
			1	1	Graduated cylinders or beakers(set
*	1	1	1	1	Outdoor thermometer
			10	10	Aluminum backed student thermometer
*	1	1	1	1	Demonstration thermometer
	1	1	1	1	Indoor Wall thermometer
				1	cm^2 graph paper (ream)
*				15	cm^2 acetate grids
Approx. Cost - no sharing between grades	$100	$200	$275	$300	

Some of these materials may already be in classrooms. Districts should take careful inventory prior to purchasing any new materials. In some instances existing materials can be adapted for metric use. A word of caution is in order, however, avoid dual labeling. Such practices have been shown to be clearly counter productive! There are some exceptional situations in which this is unavoidable, especially in I/A - Occupational Education - Home Economic contexts.

In industrial arts it is not necessary to buy metric replacements for all customary measurement tools. We will be bilingual for some time to come, therefore, we need only phase metric (or dual) instruments in over time. Replace customary tools gradually with metricly calibrated ones.

Specifically, in drafting the only pieces of metric equipment needed are scales and templates, continue customary paper sizes for some time. Woodworking conversion costs are generally low as no machines need to be replaced. Measurement tools are needed, with existing machinery easily adapted for the transition. Metric costs are higher in the metalworking area than in any other. Costs can be extended over many years, with highest priority instruments being acquired first. Conversion kits for lathes and mills are expensive, difficult and hard to install; considerable research should precede any purchase. The needs of individual programs will determine what and when to buy. Steel rulers, micrometers, calipers, thickness guages are among the required metric tools.

While graphic arts and printing are measurement sensitive areas, very few metric replacement tools are needed to provide students with basic metric experiences. Hand tools such as wrenches, guages, and rulers are the primary items needed for basic metric activity in power, energy and automotive work. Many automotive shops already carry a full line of metric tools. Since electrical units are already metric no new tools are needed there. Further information regarding this aspect can be obtained from the Center for Metric Education at Western Michigan University.

IMPLEMENTATION PLANNING

If a district is to implement a revised metric instructional program, it is essential that it do so through a carefully designed plan. The staff development, curriculum revision, and instructional resource components must dovetail if the plan is to be effective. The plan, itself, can be developed at any level within the district; but might best be developed by a district-wide group with input from as broad a spectrum of the school population as feasible (administration, teachers, students, parents, ...).

The plan should include a clearly defined time-line for its major events. This time line should be well publicized, so that all sectors of the community are well aware of it. Meetings with parents, community groups, boards of education, devoted to the why and wherefore of metrics are strongly recommended to galvanize the type of community support so essential to an effective transition to metrics.

While community support is significant, the plan must ultimately come to have full administrative support. The administrative commitment to the plan, more than any other single factor, determines its probable success in the field. Such commitment derives from a thorough understanding of the issues, the alternative solutions, and the rationale supporting the options elected. Administrative workshops can meet this need.

The plan should clearly deliniate responsibility and authority for monitoring and evaluating the implementation in an ongoing manner. Unless some individual within the administrative group is clearly deligated the authority to follow-up on metric implementation, the plans will tend to fizzle.

The number of years over which the plan itself extends is of course subject to a number of variables. The Interstate Consortium on Metric Education has recommended September 1980 as a general target date for the educational community, with the objective being a "predominantly" metric instructional program. In New York State we are having a similar date from the State Education Department as a recommended target date. The state math bureau predicts that it will publish its revised K-6 curriculum (predominantly metric) by 1979 which is reasonably close to the desired implementation date. Bureau of tests and measurements indicates revisions are planned for PEP and Basic Competency tests in future to reflect corresponding changes in measurement language, but are unable at this time to provide specific target dates. It would appear from all available evidence that most states and agencies within New York State are targeting for the early 1980's. Thus, we are talking about an implementation plan which covers three to five years depending upon local circumstances.

It should be noted that two psychologically appealing alternatives have been rejected: a twelve year, grade-by-grade phase in and a one year, "overnight" transformation. The former because it clearly will take too long and consequently would fail to accommodate our needs; the second because it has consistently proved an unworkable solution in those few places where, incredible as it may seem, it was tried!

Given the above constraints, a basic implementation plan follows. It extends over 4 to 5 years, depending upon local unkowns. It provides for staff development, curricula revision, and resource development in three stages: K-3, 4-6, 7-12. These three partionings were chosen because the nature of the tasks within each are quite similar.

Implementing metrics in the K-3 division should be accomplished with a minimum of confusion. It is not until well into the third grade that instruction in metric units perse becomes significant. Prior to that teachers are charged primarily with developing measurement concepts in general, irrespective of any language of measurement. K-3 teachers have dealt with this curricula issue traditionally, and are easily sensitised to the newer strategies and vocabulary. Given the understandable frustration they have historically experienced in attempting to teach standard imperial units, most are quite amenable to discontinuing that practice in place of non-standard units. The new resources required are minimal, and can easily be integrated into existing resource budgets.

The 4-6 modifications, on the other hand are the most fundamental within the overall school program. They will require the greatest amount of staff development and curricularevision. Their implementation will need careful monitoring - staff will require much support. This aspect is, therefore, stretched over as much as two years.

The 7-12 segment is primarily a "replacement" revision, and can, therefore, be accomplished again with a minimum of confusion. Staff development needs are less comprehensive, but more highly specialized. Material resource needs range from nominal to substantial and require discipline by discipline consideration. The overall plan at this level is, consequently, much more significantly compartmentalized and specialized.

The plan alsc provides for a full year of preparatory planning and development prior to the implementation of any revised curricula. Such lead time is essential if confusion is not to be the end product.

Needless to say, as with any such plan, there exists considerable room for modification, adaption to local situations and circumstances. School organizations might dictate a different partitioning, or current levels of involvement might allow considerable foreshortening, etc. Good judgment clearly will dictate the precise nature and scope of any locally developed plan. That which follows is merely intended to serve as an example of how the required components might be integrated to from a rationale strategy for changing the language of measurement used within a school district:

IMPLEMENTATION TIME LINE

Year # 1 (1977-'78)

- develop district-wide awareness of overall plan, rationale
- adopt Board policy and supporting administrative guidelines (Sample Appendix C)
- conduct administrators' Workshops (central & elementary administration)
- intensive staff training K-3
- curricula adjustments K-3 clarified
- acquire instructional resources K-3

Year # 2 (1978-'79)

- implement K-3 revised program and MONITOR
- continue administrative workshops: K-3 supervision of metric instruction
  4-6 developing metric curriculum
- intensive staff development: 4-6
- teacher workshops K-3, support
- curriculum revision 4-6
- instructional materials 4-6
- parent workshops K-3

Year # 3 (and possibly 4) (1979-'80, 1)

- implement 4-6 revised program, MONITOR 1-2 years
- administrative workshops: K-6 supervision of metric instruction
  7-12 implementing metrics at secondary level
- staff development 7-12: General Awareness
  Special topical workshops
- revise curricula 7-12
- acquire instructional resources 7-12
- teacher workshops 4-6, support
- parent workshops 4-6
- Adult Education courses offered

Year #4 (or 5) (1980-'81 or '81-'82)

- implement revised programs 7-12
- MONITOR K-12
- Workshops 7-12, support
- continue community workshops

It should be noted that the above plan does not provide for our present 6th through 12th grades as they are always ahead of the phase-in. Special consideration needs to be made for this group of young people, all of whom are destined, just like the rest of us, to live in a world that clearly will be a metric world.

Their training needs will be similar to those of any adult already fluent in the imperial language of measurement. They will need to be taught what they will use in everyday applications in the real world, not the entire metric system. Such training, not unlike that of younger children, however, should be as activity oriented as possible. The only way to learn metrics, is to measure, estimate and verify using metric units - as opposed to hearing about metrics. Secondary Mathematics or science teachers could, with a minimum of training provide the essential experiences to these students prior to the general implementation at the secondary level. The activities designed might also be appropriate for use in adult education and parent training workshops.

APPENDIX A - Extracted From Interstate Consortium On Metric Education - Final Report Published 1975 by the California State Department of Education

RECOMMENDATION 19

The ICME recommends that preservice and/or inservice education programs be designed to prepare elementary teachers, administrators, and support personnel involved in instruction to implement measurement using metric units. The recommended program includes two areas of concern: (a) metric awareness; and (b) metric measurement experiences for teachers and aides.

Rationale: The rationale for Recommendation 19 is presented in detail on pages 2 through 4.

RECOMMENDATION 20

The ICME recommends that preservice and/or inservice training programs for teachers at the secondary school level (grades seven through twelve) be designed to help these teachers become aware of the basic content and learning principles used in the elementary metric programs. In addition, secondary training programs should contain more concentrated, in-depth treatment of measurement for teachers in specialized areas. These specialized areas are: (a) vocational/technical education, including industrial arts, home economics, and related fields; and (b) mathematics and science.

Rationale: The rationale for Recommendation 20 is presented in detail on pages 2 through 4.

RECOMMENDATION 21

The ICME recommends that state educational agencies provide leadership by developing a core of resource personnel whose responsibility will be to implement metric education programs at the local level.

Rationale: The need for implementing a variety of metric education programs at the local level necessitates the training of resource personnel who can carry out these programs effectively. A core of resource personnel could be tained and then in turn train others to assist in implementing metric education programs all the way to the local school level.

RECOMMENDATION 22

The ICME recommends that measurement inservice programs for individuals directly involved in teaching measurement to students be of 10 to 16 hours duration. Introductory inservice programs of 3 to 6 hours duration on metric measurement should be designed for all individuals involved in instruction. In both programs, "hands-on" activities should be emphasized.

Rationale: This recommendation is needed to identify the amounts of time that are adequate for the accomplishment of the objectives for the various types of preservice and inservice programs.

RECOMMENDATION 23

The ICME recommends that (a) mathematics and science teachers assume the major responsibility for teaching the metric system; and (b) teachers in all subject areas assume the responsibility for teaching applications of the metric system.

Rationale: Teaching the metric system is a multidisciplinary concern.

SUPPORTING RATIONALE FOR RECOMMENDATION 19 AND 20

SUGGESTIONS FOR TEACHER INSERVICE TRAINING

In addition to its official recommendations, the ICME developed suggestions concerning the implementation of preservice and inservice teacher-training programs at the elementary and secondary school levels. Two areas of concern that were identified regarding both the elementary and the secondary level programs were (1) metric awareness programs; and (2) experiences with metric measurement for teachers and aides.

INSERVICE TRAINING FOR ELEMENTARY TEACHERS

To fulfill the intent of the elementary school preservice and inservice recommendation (Recommendation 19), the ICME suggests that the following components be incorporated in metric awareness programs:

1. HISTORY--A brief historical background on measurement should be presented that includes progress made in the implementation of SI metrics at the local, state, national, and international levels.

2. ADVANTAGES OF THE SI METRIC SYSTEM--The advantages of SI metrics that teachers should be aware of include (a) SI metrics is based on decimal numeration similar to the U.S. monetary system, and the SI system is therefore easy to understand and use; and (b) the coherence and simplicity of SI metrics are factors that have contributed to its official acceptance by approximately 90 percent of the world's population.

3. RESISTANCE TO CHANGING TO SI METRICS--Teachers should be prepared to expect some natural resistance to the acceptance of the SI metric system and should be able to cope with this resistance in a positive manner.

4. INTRODUCTION TO SI METRIC UNITS--Teachers should have the opportunity to use common SI metric units, such as by holding a kilogram mass.

The ICME suggests that experiences with metric measurement for elementary level teachers and aides include the following:

1. Activities similar to those in which students will be involved. The activities should range from free exploration with a variety of materials to such structured exercises as the following:

   a. Measurement activities directly related to real world situations
   b. Construction and use of simple measurement devices
   c. Games, puzzles, and problems to develop and reinforce the basic concepts and skills of measurement and to achieve proficiency in conversion techniques within the metric system

2. Informal and formal diagnostic techniques that enable the teacher to determine the level of conceptual and skill readiness of students

3. Experiences that enable teachers to acquire a knowledge of the prefixes, symbols, and notation terminology used in SI metrics

4. Experiences that enable teachers to use a varity of community resources

5. Opportunities to examine a variety of learning materials for measurement

INSERVICE TRAINING FOR SECONDARY TEACHERS

To fulfill the intent of the secondary school preservice and inservice recommendation (Recommendation 20), the ICME suggests that the following metric subjects be treated in metric-awareness programs:

FOR ALL TEACHERS IN GRADES SEVEN THROUGH TWELVE
- Historical background
- Legal status (federal, state, and local)
- Implications of metric implementation (national economy, education and consumer)
- Familiarity with units of length, mass/weight, time, temperature, volume/capacity, and speed
- Decimal system of numeration (similarity to U.S. monetary system)
- Metric prefixes and symbols
- Issues and concerns

FOR VOCATIONAL/TECHNICAL TEACHERS
- Familiarity with essential metric units, prefixes, and symbols
- Industrial uses
- Mass-weight clarification
- Other skills needed for specific subjects
- Funding opportunities

FOR MATHEMATICS AND SCIENCE TEACHERS
- Technical definitions of base units
- Derived and supplemental units
- Scientific notation

The ICME suggests that experiences with metric measurement for teachers and aides include the following topics:

FOR ALL TEACHERS IN GRADES SEVEN THROUGH TWELVE
- Personal measurements
- Estimations and verifications
- Error in measurement and approximation
- Travel distances
- Selection of appropriate units
- Construction and calibration of measuring instruments
- Practice with measuring
- Conversion within metric system
- Unit pricing practices
- Criteria for selection of instructional materials

FOR VOCATIONAL/TECHNICAL TEACHERS
- Vernier scales
- Metric (radial) protractors
- Map and scale drawing skills
- Mensuration formulas
- Instruments used in specific courses
- Visitation of exemplary programs

FOR VOCATIONAL/TECHNICAL TEACHERS AT THE SENIOR HIGH SCHOOL LEVEL ONLY
- More sophisticated instruments
- Conversion skills needed for specific courses

FOR MATHEMATICS AND SCIENCE TEACHERS
- Very small and very large units of measurements
- Application of time units
- Factor label/unit analysis
- Map and scale drawing skills
- Mensuration formulas
- Instruments used in specific courses
- Visitation of exemplary programs

FOR MATHEMATICS AND SCIENCE TEACHERS AT THE SENIOR HIGH SCHOOL LEVEL ONLY
- Derived units as needed
- General physical constants
- Derivation of physical formulas
- More sophisticated instruments
- Conversion skills needed for specific courses

APPENDIX B - Outline Of Inservice Course Offered By Comprehensive Metric Education Project

Inservice Course: OUTLINE

Session # 1 Pre-test
Awareness extended - the metric language, an overview.

Activity #1 Style rules - how to write metrics

Session # 2 How Children Learn Measurement - how children come to acquire measurement competencies, educational research and theories of learning, conservation and learning processes.

Activity #2 The use of Non-Standard Units - measurement experiences using non-standard units of length which lead the participant to an understanding of the need for standard units.

Session # 3 Activity #3 The Metre - each participant builds and calibrates his own metre stick or tape, uses the instrument to make a number of measurements, and then estimates and verifies a number of linear measurements.

Session # 4 Precision in Measurement, Intra-system Conversion - a discussion of the need for a consideration of the concept of precision in the teaching of measurement, that all measurements are approximations. This is followed by a consideration of metric-metric conversions, the technique and the need for such.

Activity #4 Area - participants use area grids to determine the area of regions and then estimate and verify areas in cm^2, mm^2, m^2.

Session # 5 Teaching Children to Measure - some pedagogical guidelines for the teaching of measurement to children, related more to process than to content.

Activity #5 Volume - an experience with the basic units of liquid and dry volume in the metric system.

Session # 6 Curricula Implications - a consideration of the impact metrics will have on the K-12 curriculum in all subject areas.

Activity #6 Mass - an experience with the basic units of mass in the metric system, with a distinction being made between mass and weight.

Session # 7 Motivation in the Teaching of Measurement - a consideration of the need to motivate learners in the teaching of measurement and the various ways in which this can be accomplished. Guidelines for the development of constructive games are provided, as well as some cautionary notes. Effective uses of audio-visual materials are also considered.

Activity #7 Metric Madness - an instructional game that allows participants to develop competency in estimation skills with: length, mass, volume, and area. Games requires measurements to be estimated first and then verified.

Session # 8 Instructional Resources in Metric Education - a consideration of what is available, what is needed, what would be nice to have, and what isn't needed. Criterion for the selection of resources are also considered.

Activity #8 Designing metric resources from readily available materials - participants design and build instructional resources for classroom use.

Session # 9 Derived Units in the Metric System, Implementing Metrics in the Classroom - some Do's and Don'ts

Activity #9 A Metric Revue - an activity designed to encourage participants to THINK METRIC.

Session # 10 Metric Temperature
Post-test
Course evaluation
Open discussion

APPENDIX C - Guidelines For Metrication

IT IS THE POLICY OF _____
School District that:

1. The metric system become the principal system of measures in the cirriculum of the elementary and secondary schools of the district.

2. Metric conversion be implemented on the schools with the express intention of ensuring that programs of instruction become predominantly metric by September 1980.

3. Metrication be applicable to all areas of the curriculum and that all measured quantities, wherever appropriate be stated in metric units.

4. The units and symbols of the metric system taught in the schools conform to those of the International System of Units, known as S. I.

5. Metric education be accepted as an opportunity to reassess pedagogical approaches of the topic of measurement as a whole; that students be provided with opportunities to acquire a practical and experiential knowledge of metric units through activities that involve comparing, estimating, measuring, and related problem-solving.

6. Metric changes in the curriculum be coordinated with corresponding changes in industry and commerce.

7. Metric conversion of learning materials in the schools be carried out on a pre-planned and gradual basis; with due consideration being given to the attrition, modification, and replacement of materials, as well as to the availability of new learning materials.

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